

Catalysis, sensing and regulation in a synthetic-bio hybrid system

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Abstract

All the biological functions originate from some molecular actions. Catalysis, sensing and regulation are the three basic elements required for biochemical reaction to function properly in an organism. How the biochemical reactions can be built on semiconductor chip, regulated and translated into digital signals for further artificial functions are the goals of our research. Three principal subjects are investigated: (1) to develop a highly sensitive and selective nano-biosensor, of which the scheme must be highly reproducible and compatible with low-cost Si process; (2) to develop a novel bioactivity regulator, which uses a locally-intensified electric field to induce the conformational change of enzymes immobilized on a Si base substrate, and therefore regulates their activities; (3) to construct a bionic system at bioreaction level by integrating the above-mentioned nano-biosensor and bioregulator developed in this project. Currently, we are developing a nanowire biosensor (poly crystalline silicon nanowire field effect transistor, PSNW-FET) with novel and reliable processes. The ultra-high sensitivity and specificity of PSNW-FET have been demonstrated^{1,2,3,4}. A bioreactor MEMS system that in situ determines the activity of immobilized enzyme has also been developed⁵. The feasibility of using electric field for the regulation of immobilized enzyme has also been initially verified. Currently, integration and assembly of the biosensing, bioregulating, and NEMS/MEMS technologies into a multi-functioned bionic platform are in progress. Applications of the synthetic-bio hybrid system in biomedical and other areas are also currently investigated.

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Bibliography

Yuh-Shyong Yang received his Ph.D. degree in Biochemistry from the University of Wisconsin, Madison in 1987. He worked in National Institutes of Health, Bethesda, USA, for five years before returning to Taiwan, where he is currently a Professor of the Institute of Molecular Medicine and Bioengineering, National Chiao Tung University and an adjunct Research Fellow of Instrument Technology Research Center and National Nano Device Laboratories, National Applied Research Laboratories. He was the Chair of the Department of Biological Science and Technology (1999-2001; 2005-2006), Director of the Institute of Biochemical Engineering (2003-2005) and Active Dean of the College of Biological Science and Technology (2006-2007), National Chiao Tung University. His research interests involve in two distinct disciplines, biochemistry and engineering. In particular, he is interested in how specific interaction between biomolecules may affect electronic response from semiconductor devices and how the electronic signals can be used to generate other artificial function. In the biochemistry area, he is interested in the exploration of enzyme mechanisms and their biological significance. He is coordinating expertise in academics, national laboratories, IC industry and hospitals and wish to help to breed a unique medical electronics industry that can fully take advantage the Taiwan's strength in microelectronics.